

enervation is always the consequence. The feeble layer of live peripheric wood is no longer able to give nourishment to the large crown of the tree, formation of new wood has nearly ceased altogether, and every year a new number of branches die out, while only here and there a desolate twig, whose few leaves have a conspicuous, light color, show that life still lingers in the old trunk, but that in a short time its end will come.

The process is different in those wood plants the vessels of which, even in old age, are still filled with liquid, such as the birch and the willow. Their death is not caused by enervation, but their vessels and tubes, full of sap, enter into a state of dissolution, which is introduced by the action of fungi and other parasites which take up their abode inside of the vessels. Finally decay spreads out more and more, new parts of the healthy wood are attacked and fall into pieces, till a strong blast of wind ends the long disease.

BENZOLE.

This name is applied to a lightly oily liquid consisting of equal equivalents of hydrogen and carbon. Since the atom of carbon is twelve times as heavy as that of hydrogen, of course benzole contains twelve times as much carbon by weight as it does of hydrogen. Its percentage composition is: Carbon, 92.3; hydrogen, 7.7. Not every substance, however, having this percentage composition is benzole, for acetylene, a bad smelling gas, has the same composition, and chemists say they are isomeric. To benzole they give the formula C_6H_6 , meaning there are six atoms of each element in the molecule, while acetylene has but two of each, and is written C_2H_2 . How do they know this? it may be asked. Because the vapor of benzole is three times as heavy as that of acetylene; the former being 39, the latter 13, with hydrogen as a unit.

Before passing on to a description of benzole and how it is made, we must refer to the confusion caused by its having too many names. Faraday, who discovered it in 1825, called it bicarburet of hydrogen, because in those days the atomic weight of carbon was but half as large as now. Next it was called benzene, and this name still adheres to it in England and France, while in Germany and this country it is called benzole. Here the term benzine is limited very properly to the light petroleum oils which boil between 80° and 100° C.

Pure benzole is formed by heating benzoic acid with quicklime. In a less pure form it is obtained when organic matter is highly heated; thus, Faraday found it in illuminating gas made by heating the fatty oils, and Woehler made it by the dry distillation of quinic acid. At the present time it is usually made from coal tar, the refuse of the gas house, in which it was discovered by Leigh in 1842, and by Mansfield in 1847.

Coal tar is a mixture of a great number of different bodies, both solid and liquid. By distillation it is separated into three portions: the first, boiling below 150° C. (302° F.), is called light oil; the second portion is heavy oil, or dead oil, while a sort of pitch remains behind. Benzole is made from the light oil, and the commercial article is very impure, containing only 40 per cent of benzole; the remaining 60 per cent is chiefly toluol, C_7H_8 , a substance quite similar to benzole, but of higher boiling point and richer in carbon. This impure benzole makes better aniline dyes than the pure, as we shall afterwards see. By careful fractional distillation a nearly pure benzole is obtained, which is then still further purified by freezing it and pressing out the crystals. Pure benzole boils at 80° C. (177° Fah.), and when cooled solidifies, forming tufts of crystals, which melt at 5½° C. (42° Fah.). It is insoluble in water, but soluble in alcohol, ether, and wood spirits. It possesses remarkable solvent properties, surpassing those of benzene or petroleum naphtha. It is an excellent solvent for India-rubber, gutta percha, the fixed and volatile oils, wax, and camphor; it also dissolves copal, gum lac, sulphur, phosphorus, and iodine, as well as a very large number of organic bodies. It is very inflammable and burns with a smoky flame. Many accidents have occurred from heating or distilling it over an open fire. If it is mixed with two volumes of alcohol it can be used as a lamp oil. When illuminating gas is passed through benzole its illuminating power is greatly increased. An apparatus for enriching poor gas is sold under the name of Woodward's carbureter.

The most remarkable and valuable property of benzole is its ability to form substitution and addition compounds. Chlorine is able to replace each and every atom of hydrogen in benzole, and, besides this, one or more atoms of chlorine, to the number of six, can be added to the molecule of benzole.

Mono-chloro-benzole, C_6H_5Cl , is formed when chlorine is passed into benzole containing iodine. It boils at 138° C. There are two kinds of dichloro-benzole, one melting at 53° C., the other below zero. There are also two kinds of trichloro-benzole, as well as of the tetrachloro-benzole. Of the pentachloro-benzole, of course, but one form is possible if Kekule's ring-shaped formula is true; yet Jungfleisch and Otto both assert that they have made two kinds. When all six atoms of hydrogen are replaced by chlorine we have a chloride of carbon C_6Cl_6 . It is made by pouring benzole on antimony chloride and then passing in chlorine as long as it is absorbed. It forms silky needles, melting at 220° C.

Thus it will be seen that benzole forms at least nine chlorine substitution compounds. With bromine and iodine it forms nearly as many, although the latter are more difficult to prepare. By the action of chlorine upon benzole in sun-

light an additive compound, C_6H_5Cl , is formed, and in like manner chlorine may be added to the substitution compounds forming such bodies as $C_6H_4Cl_2$ and $C_6H_3Cl_3$.

A much more important series of substitution compounds is that formed by the action of nitric acid on benzole.

Nitro-benzole, $C_6H_5NO_2$, in which an atom of hydrogen is replaced by the NO_2 group, is a yellow oil, heavier than water, and of an agreeable odor, resembling that of bitter almonds. In commerce it is known as essence of mirbane. It is formed when benzole is poured slowly into fuming nitric acid as long as the benzole dissolves. The mixture is then poured into a large quantity of water (in which it sinks) and thoroughly washed. It should next be distilled in a current of steam, and may afterwards be distilled *per se*. On a large scale it is prepared by acting on benzole with sulphuric acid and sodic nitrate, or a mixture of ordinary nitric acid (sp. gr. 1.3) and strong sulphuric acid. It is a violent poison when taken internally, two drops having in one case caused death. When pure benzole is employed in its manufacture the purified nitro-benzole boils at 210° C.; when commercial benzole containing toluol is employed the resulting product is a mixture of nitro-benzole and nitro-toluol, and boils at a much higher temperature.

When nitro-benzole is acted upon by a mixture of sulphuric and fuming nitric acids, a solid dinitro-benzole is formed, which crystallizes in long needles. It is soluble in alcohol, but insoluble in water.

In addition to the two nitro-benzoles, there are several nitro-chloro-benzoles, as well as nitro-bromo and nitro-iodo compounds.

The nitro-benzoles are readily converted, by means of reducing agents, into amido compounds by substituting NH_2 for NO_2 . Amido-benzole, $C_6H_5NH_2$, which is much better known under the name of aniline oil, is prepared on a large scale by the action of acetic acid and iron filings on nitro-benzole.

Aniline was first discovered by Unverdorben in Saxony in 1826, among the products of the distillation of indigo. In 1833 Runge discovered it in coal tar, and called it kyanol. In 1842 Zinin, recently deceased, prepared it from nitro-benzole by reduction with sulphhydric acid; he called it benzidam. A. W. Hofmann, of Berlin, subsequently proved the identity of all these substances. The name aniline was given to Unverdorben's new compound by Fritzsche from *anil*, meaning indigo.

Pure aniline is a colorless liquid of bitter taste and unpleasant odor, which soon turns brown in the air. It boils at 184.8° C. The admixture of toluidine, etc., raises its boiling point.

When heavy aniline oil of higher boiling point is treated with certain oxidizing substances it is converted into a base called rosaniline or fuchsine, $C_{20}H_{15}N_3$, the salts of which have a beautiful green color when solid, a magnificent red when in solution. Arsenic acid is the reagent mostly employed in making rosaniline, although corrosive sublimate, nitro-benzole, and perchloride of tin are also used. A description of the methods employed in the manufacture of the aniline colors would far exceed the limits of our present article.

Diazo-benzole is a benzole derivative containing, as the name implies, two atoms of nitrogen. It is obtained as a nitrate by passing nitrous acid gas into a solution of the nitrate of aniline. Also as the hydrochlorate by dissolving aniline in an excess of hydrochloric acid and adding potassic nitrite. In a dry state the diazo compounds are dangerously explosive, and even in solution undergo spontaneous decomposition. By the action of various diazo compounds upon the phenols, Griess has obtained a great variety of dyes, some of them quite interesting and beautiful, and still they come. James H. Stebbins, Jr., of this city, has also made a number of dyes from diazo compounds.

Sulphanilic acid, $C_6H_5NSO_3$, is formed by the action of sulphuric acid upon aniline at a high temperature; in the cold only sulphate of aniline is formed. It crystallizes from hot water in rhombic plates. Two other acids having the same composition may be obtained, the one from sulpho-benzoic acid, the other from nitro-benzole. In making the former acid, sulpho-benzoic acid is first converted into a nitro-sulpho-benzoic acid, and that reduced to amido-sulpho-benzoic acid. It crystallizes in white needles.

In the above sketch we have described but a few of the most important derivatives of benzole. The list might be prolonged to an almost limitless extent by adding the various chloro and nitro derivatives of each of the above compounds, the acids derived from them, their salts, ethers, and esters; but these must wait until they have become of greater industrial or technical importance than they are at present, before they can claim a place in our crowded columns.

The Leather Industry of Philadelphia.

One of the oldest of the staple industries in Philadelphia is the manufacture of Morocco leather, which began early in the present century, and was an outgrowth of the East India trade that once distinguished that port, and continued fitfully until 1861. The Morocco leather manufacture, however, grew steadily, and is now more prosperous than ever before. There are thirty establishments, says the *Public Ledger*, making goat skin Morocco to the value of \$5,056,000 for the last year, as compared with twenty-three in 1870, then producing \$2,307,113 in value. The improvement effected by the introduction of steam machinery has given most of this increase, and the demand for fine leather in shoe manufacture takes all that the factories can produce.

A few cases have been sent to foreign markets, but it is not a regular trade, as the export of sole leather has become. More than half the supply of sumac, the chief tanning material, is now produced in Virginia; formerly it was all brought from Sicily.

Next to the Morocco manufacture is that of calf-kid and glove-kid, nine factories producing \$1,050,000 in value, as compared with \$574,043 in 1870. A still larger product is that of colored and fancy leathers, bindings, and linings, chiefly of sheep skin, fifteen establishments producing \$1,500,000 in value, as compared with \$1,133,568 in 1870. The tanning of heavy leather, sole and upper, has declined, and many of the old yard tanneries have disappeared. But six or seven remain, producing \$314,600 in value, as compared with \$523,000 in 1870. A large industry remains in currying and preparing leather, although this has declined under the competition of the great steam tanneries of the interior of the State. The produce of about twenty of those tanneries is regularly sold in Philadelphia, one-half of it for export to foreign countries. The value, so handled, is about \$6,000,000, and is increasing.

The only feature of the old order of things remaining is the importation of French and Belgian calf skins, which continues at about \$750,000 in value yearly, although in the manufacture of calf-kid and like leathers here, the Alsatian and Belgian workmen, transplanted bodily to Philadelphia, give to Canal street and St. John street the air and flavor of the most ancient city of the continent. The only thing lacking, it is said, is time. The continental tanner has months or years before him without limit, whereas time with us is cut off at both ends, and the leather must be out of the tannery in a month. So Philadelphia brings into North Third street every year half a million dollars' worth of the best products of the North of France and adjacent Germany, leaving the poorest for Europeans to wear, because our bootmakers will have the best of French calf skins, or none at all.

In manufactures of leather, including every form of cut leathers in belting, bands, harness, straps, etc., the industry is conducted with great activity. Belting is made for export, and the clean and perfectly finished belts of Pennsylvania leather are now driving machinery in England and Scotland, in Sweden, and in Australia. Even the great factories of Mulhouse would have procured 46-inch belts here if they could, but in France the importation of manufactures of leather is prohibited.

In leather strictly embracing none but finished forms, the total value of that manufactured for the past year is \$8,000,000—an increase of 33 per cent over 1870. The establishments are little subject to depression, and rarely to disturbance. Whatever may happen to other departments of business, the special forms of leather made in Philadelphia are always in demand, and there is no record of a corner in the market for Patna or Tampico goat skins.

MECHANICAL INVENTIONS.

Mr. Fredrick P. Danunhauer, of Philadelphia, Pa., has patented an improved apparatus for dyeing yarns which consists, first, in a series of nipping rollers hung on vibrating arms and fitted for movement to and from the supporting bars of the yarn to draw the yarn around the bars a regulated distance at each vibration; second, in an automatic stop motion for shifting the driving belt and stopping the mechanism when the desired number of turns have been given to the skeins, so that they may be removed.

An improved retracting device for the picker sticks of looms has been patented by Mr. James J. Geoghegan, of Westerly, R. I. The object of this invention is to provide a simple, durable, and inexpensive device for pulling back the picker sticks of looms, whereby the expenses and delays consequent upon the frequent breaking of the ordinary picker stick spring will be avoided. The invention consists of a rocking lever to one end of which the picker stick is connected, while to the other end weights or springs are attached to pull back the picker stick after each forward motion.

Messrs. Richard Matthai and Charles A. Clinton, of San Francisco, Cal., have invented a simple device for indicating to railroad car passengers the names or numbers of streets and stations on the line of the road as the car approaches them. The invention consists of a box or case containing rollers over which is rolled an index strip having the names or numbers of the streets and stations printed on it, which names or numbers are exhibited in proper succession through an aperture in the box as the rollers are revolved; and also of a novel combination of wheels, springs, levers, and other devices, whereby the said rollers are moved and a bell simultaneously sounded when desired.

Causes of the Present Figure of the Earth.

The *Comptes Rendus* of the French Academy contains a remarkable paper by M. Faye on the physical forces which have produced the present figure of the earth. After remarking on the use of the pendulum in determining the figure of the earth from series of measurements of the intensity and direction of the gravitation force at different parts of the earth's surface, he draws attention to the very curious fact that while the direction and intensity of gravity are affected perceptibly by the presence of hills such as Schichallion and Arthur's Seat, or even by masses as small as the great pyramid of Gizeh, gigantic mountains such as the Himalayas, and great elevated plateaux and table lands, do not affect the pendulum indications in any sensible man-